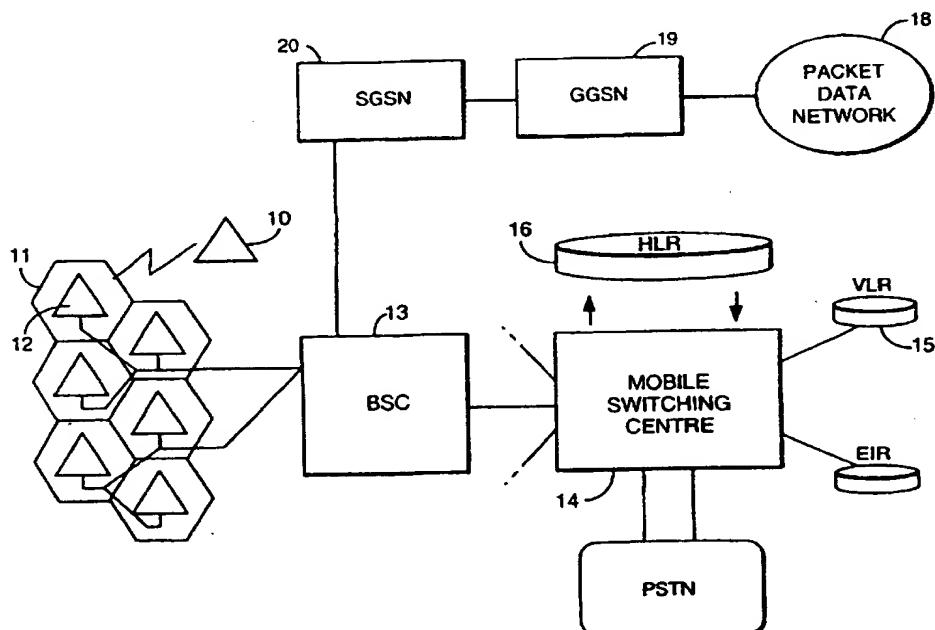




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : <b>H04Q 7/22, H04L 12/56</b>		A1	(11) International Publication Number: <b>WO 97/21313</b>
			(43) International Publication Date: <b>12 June 1997 (12.06.97)</b>
(21) International Application Number: <b>PCT/GB96/02962</b>		(81) Designated States: US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).	
(22) International Filing Date: <b>29 November 1996 (29.11.96)</b>		Published <i>With international search report.</i>	
(30) Priority Data: 9524585.8 1 December 1995 (01.12.95) GB 9524649.2 1 December 1995 (01.12.95) GB			
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(54) Title: MOBILE PACKET DATA COMMUNICATIONS SYSTEM



## (57) Abstract

Packet data is routed from a packet data network (18) to a mobile subscriber (10) served by a base station (12) and a base station controller (13) by encapsulating the packet and providing the encapsulated packet with temporary address information for transport of the packet to the mobile subscriber (10) via the base station controller (13).

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## MOBILE PACKET DATA COMMUNICATIONS SYSTEM

This invention relates to mobile communications systems and in particular to the provision of packet data services in a mobile system.

### **BACKGROUND OF THE INVENTION**

5    Mobile telephone networks were originally developed to provide voice services to customers. However, customers are now demanding access to many of the services, including packet data services, that are provided on the conventional wired network. A general description of a packet data network is given in specification  
10   No. WO 95/16330 and in specification No. EP-A2-0,642,283.

It is of course difficult to determine the precise location of a mobile user who is free to roam throughout the mobile service area. There is thus a problem of routing traffic from a fixed packet data network to  
15   the mobile subscriber. In the normal circuit switched network this problem is addressed by using the call forward facility to direct a mobile terminated call to the mobile switching centre (MSC) serving the subscriber. In a fixed packet data network however, this call forwarding facility is not provided and thus the support of dynamic  
20   routing to mobile customers can be difficult and costly. This is a particular problem as, unlike a circuit switched call where a connection is established for the duration of the call, each packet must be delivered separately to the correct mobile terminal.

### **25   SUMMARY OF THE INVENTION**

The object of the invention is to minimise or to overcome this disadvantage.

It is a further object of the invention to provide an improved method and apparatus for routing packet data to terminals in a mobile communications network.

- 5 According to one aspect of the invention there is provided a method of routing packet data from a packet data network to a mobile network subscriber terminal served by a base station controller and a mobile switching centre for provision of voice facilities to the terminal and by a mobile packet switch for delivery of packet data to the
- 10 terminal, each said mobile terminal adapted to receive packet data services having a respective public network data number allocated thereto, the method including encapsulating each data packet, providing from the mobile network to the data packet information indicative of the mobile network location of each said mobile terminal
- 15 adapted to receive packet data services, providing each said encapsulated data packet with a temporary address corresponding to said mobile network location whereby that packet is routed via the packet switch to the base station controller serving that mobile terminal, decapsulating the data packet, and delivering the packet to
- 20 the mobile terminal.

According to another aspect of the invention there is provided a mobile communications network having means for delivery of packet data services from a packet data network to mobile terminals served by the mobile network, the mobile network including a mobile switching centre for providing voice communication facilities to mobile terminals via respective base station controllers and base stations, a home location register for storing information relating to said mobile terminals, and packet switching means providing an interface between the packet data network and said mobile terminals via the respective base station controllers, the network including means for encapsulating each data packet, means for retrieving from the mobile network to the data packet network said stored information indicative of the mobile network location of each said mobile terminal adapted to receive packet data services, means for providing each said encapsulated data packet with a temporary

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address corresponding to said mobile network location whereby that packet is routed via the packet switch to the base station controller serving that mobile terminal, and means for decapsulating the data packet, and delivering the packet to the mobile terminal.

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According to a further aspect of the invention there is provided a mobile communications network having means for delivery of packet data services from a packet data network to mobile terminals served by the mobile network, the mobile network including a mobile switching centre for providing voice communication facilities to mobile terminals via respective base station controllers and base stations, a home location register for storing information relating to said mobile terminals, a packet routing system comprising a gateway support node providing an interface with the packet data network and one or more serving support nodes each coupled to the gateway support node and to one or more base station controllers for delivery of data packets to the mobile terminals, the packet routing system including means for encapsulating each data packet, means for retrieving from the mobile network to the data packet network said stored information indicative of the mobile network location of each said mobile terminal adapted to receive packet data services, means for providing each said encapsulated data packet with a temporary address corresponding to said mobile network location whereby that packet is routed via the packet switch to the base station controller serving that mobile terminal, and means for decapsulating the data packet, and delivering the packet to the mobile terminal.

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The mobile terminal address may be a data network number or a roaming data number.

#### **DESCRIPTION OF PREFERRED EMBODIMENTS**

Embodiments of the invention will now be described with reference to the accompanying drawings in which:

35 Figure 1 is a schematic diagram of a mobile telecommunications network supporting both voice and packet data services;

Figure 2 illustrates the network of figure 1 in further detail showing the signalling and data transfer interfaces;

5 Figures 3a and 3b are flowcharts illustrating the state models of a mobile terminal and a packet data server in the network of figures 1 and 2;

10 Figure 4 is a chart illustrating a combined IMSI/packet service attach procedure for a mobile terminal in the network of figures 1 and 2; and

15 Figures 5 and 6 illustrate encapsulated data packet formats for data transport respectively between support nodes and between a server support node and a mobile terminal in the network of figures 1 and 2;

Referring to figures 1 and 2, the mobile system, which may for example conform to the European GSM or to the North American PCS 900, standard, includes an array of cells 11 each served by a respective base station (BTS) 12 providing communication with subscriber terminals 10 currently located in that cell. A number of base stations are controlled by a base station controller (BSC) 13 which in turn is coupled to a mobile switching centre (MSC) 14. The 20 mobile switching centre incorporates a database or visitors location register (VLR) 15 containing information on the cellular location of mobile terminals 10 currently in the service area of that mobile switching centre. Movement of a mobile terminal from one system cell to another results in corresponding updating of the information 25 relating to that terminal stored in the VLR. Information on all system mobiles 10 is stored in a central database or home location register (HLR) 16 which may be accessed by the mobile switching centre to update the VLR whenever a mobile terminal enters the service area of the mobile switching centre. Verification of a mobile terminal's right 30 to access the system may be performed by comparison of that terminal's international mobile subscriber identity (IMSI) with 35

corresponding information stored in an equipment identity register (EIR) associated with or forming part of the VLR.

The mobile switching centre provides a coupling between the mobile system and fixed networks, e.g. a PSTN 17 for voice and circuit data services to the mobile terminals. Packet data services are provided to the mobile terminals from a fixed packet data network 18 via a gateway general packet radio service support node (GGSN) 19 and a serving support node (SGSN) 20 which provide a packet switching function to control routing of data packets to respective mobile terminals within the mobile network. In this arrangement, the GGSN and SGSN are considered as forming part of the mobile network and thus provide an interface between the mobile network and the data network. Signalling interfaces are provided between the home location register and the GGSN and SGSN, and between the mobile switching centre and the BSC and SGSN. As shown in figure 1, information relating to packet data services may be stored in a general packet radio service register (GR) 21 associated with the home location register rather than in the home location register itself.

Information relating to mobile terminals is provided to the gateway support node 20 from the home location register 16 or from the general packet radio service register 21 to facilitate routing of data packets to mobile terminals via an appropriate serving support node 20. This information is stored in the gateway support node 20 and is updated directly or indirectly by the home location register only when necessary, e.g. when a mobile terminal moves from the service area of one mobile switching centre to another.

Referring now to figures 3a and 3b, these illustrate the packet data service attachment and detachment procedures for a mobile terminal and a serving support node respectively. In each case, the movement from one state to the next is dependent on the current state and the event that has occurred. The general combined IMSI/packet services attach procedure for a mobile terminal is illustrated in figure 4

In the mobile network, each subscriber terminal 10 is allocated a public data network number which is used within the mobile network as a roaming number by the mobile terminal for packet data purposes. This number is allocated when the mobile terminal initiates the attach function and corresponds to a temporary logical link identity for the delivery of data services to the terminal. In one embodiment of our arrangement, the home location register 16 includes a facility for translating this data network number into the subscriber's international mobile station identity (IMSI) and for providing this information to the gateway support node 19. This provides a common initial point of contact with the packet data network and the administration of network resources is simplified by concentrating the information into a single entity.

Within the network of figures 1 and 2, data packets are encapsulated and subsequently decapsulated for routing purposes between the packet data network and the mobile terminal. Two forms of encapsulation are employed, one for routing the packet between the GGSN and SGSN and the second for routing from the SGSN to the mobile terminal. Each packet is decapsulated prior to delivery to the mobile terminal. As shown in figure 4, each data packet incorporates a payload and a header including a support node (GSN) address and a message end point identifier (DEST) determined from that terminal's public data number together with location information provided from the HLR or, where the packet data is to be multicast to a group of subscribers, the IMGI (international mobile group identity) of that subscriber group. The header may also contain information identifying the type of message, i.e. indicative of whether the message is point-to-point, multicast or broadcast. For routing from the SGSN to the mobile, the data packet is encapsulated, as shown in figure 5, with a header incorporating the logical link identifier and, where more than one data protocol is employed, a service access point identifier. Each packet is thus routed via the GGSN and SGSN to the base station controller serving the mobile terminal.

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Decapsulation of the packet is performed, e.g. by the base station controller prior to delivery of the packet to the mobile terminal.

The requirements for identifiers are detailed in Table 1 below which  
5 relates to service provider messages and in Table 2 below which relates to service subscriber messages:-

**Table 1****Service Provider Message Header**

	Singlecast Ack	Singlecast Unack.	Multicast	Broadcast	Acknowledge
Provider Identifier	M	M	M	M	M
Message Type Identifier	M	M	M	M	M
Subscriber Identifier	M	M	NA	NA	M
User Identifier	O	O	M	M	NA
Group Identifier	NA	NA	M	NA	NA

**Table 2****Service Subscriber Message Header**

	Registration	Deregistration	Singlecast Ack.	Singlecast Unack.	Acknowledge
Provider Identifier	M	M	M	M	M
Message Type Identifier	M	M	M	M	M
Subscriber Identifier	M	M	M	M	M
Area Identifier	NA	NA	NA	NA	NA
Group Identifier	NA	NA	NA	NA	NA

In Tables 1 and 2, the reference M signifies that the identifier is mandatory, O that an identifier is optional, and NA that an identifier is not Applicable

- 5 In a second embodiment, a roaming data call number is employed for each subscriber terminal. In this arrangement, the user's data call number is forwarded by the GGSN to the home location register 16. To ensure routing of the data packet to the correct SGSN for delivery to the mobile terminal 10, the HLR changes the current address
- 10 associated with the packet into a roaming data number that is then used to address the SGSN currently serving the mobile terminal. This number is fixed in the network and routes the packet to the serving SGSN which is then responsible for forwarding the packet on the radio link with the mobile terminal's correct address. The mobile
- 15 terminal 10 which is listening to the radio link can then recognise its own address and extract the data packet. Any response by the mobile can use its own address. Alternatively, a semi-permanent association may be made for the duration of the data transfer

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**CLAIMS:**

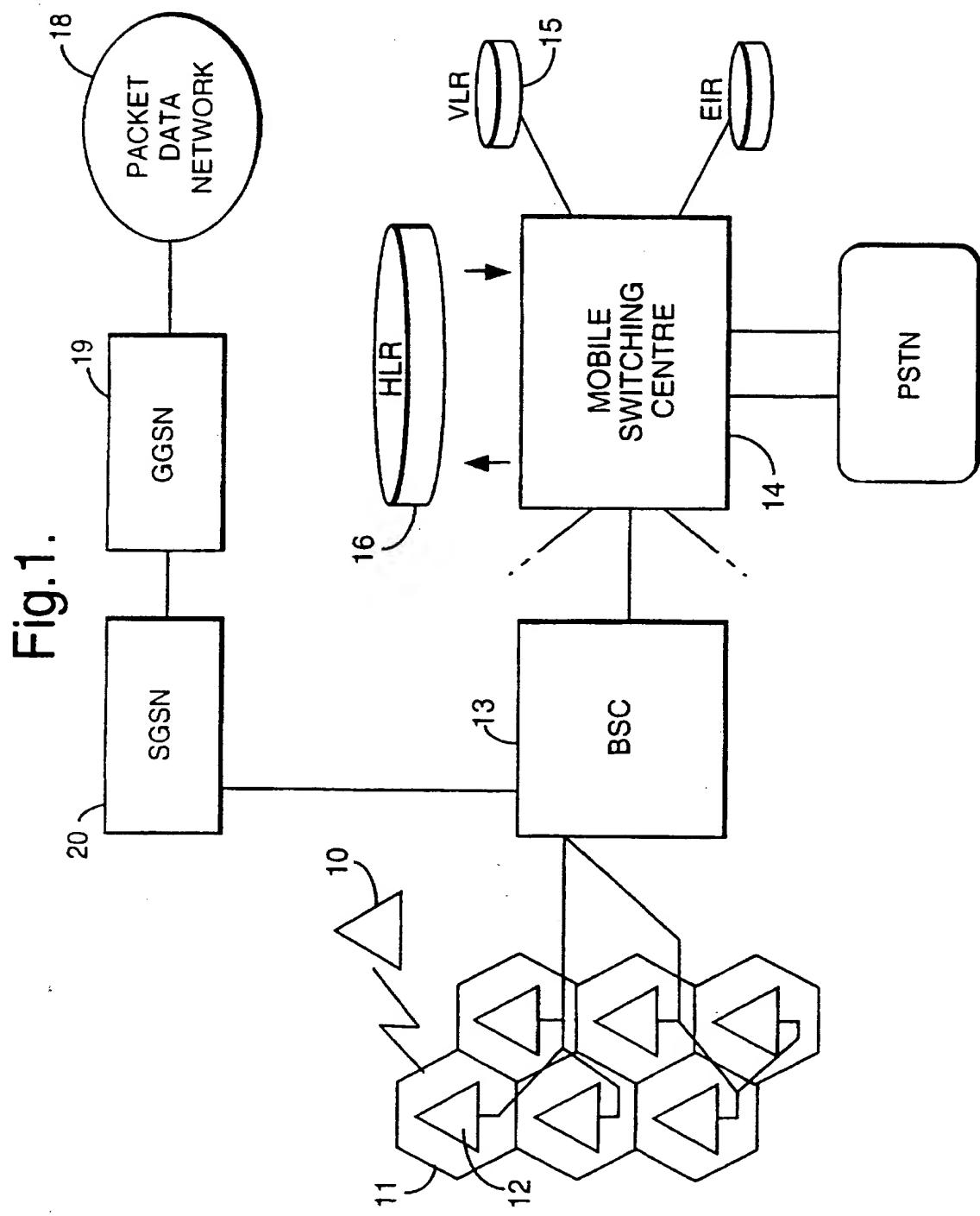
1. A method of routing packet data from a packet data network to a mobile network subscriber terminal served by a base station controller and a mobile switching centre for provision of voice facilities to the terminal and by a mobile packet switch for delivery of packet data to the terminal, each said mobile terminal adapted to receive packet data services having a respective public network data number allocated thereto, the method including encapsulating each data packet, providing from the mobile network to the data packet information indicative of the mobile network location of each said mobile terminal adapted to receive packet data services, providing each said encapsulated data packet with a temporary address corresponding to said mobile network location whereby that packet is routed via the packet switch to the base station controller serving that mobile terminal, decapsulating the data packet, and delivering the packet to the mobile terminal.  
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2. A method as claimed in claim 1, wherein a subscriber data network number is translated into the corresponding international mobile station identity.  
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3. A method as claimed in claim 1, wherein each subscriber terminal is allocated a roaming data number.  
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4. A mobile communications network having means for delivery of packet data services from a packet data network to mobile terminals served by the mobile network, the mobile network including a mobile switching centre for providing voice communication facilities to mobile terminals via respective base station controllers and base stations, a home location register for storing information relating to said mobile terminals, and packet switching means providing an interface between the packet data network and said mobile terminals via the respective base station controllers, the network including means for encapsulating each data packet, means for retrieving from the mobile network to the data packet network said stored  
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information indicative of the mobile network location of each said mobile terminal adapted to receive packet data services, means for providing each said encapsulated data packet with a temporary address corresponding to said mobile network location whereby that 5 packet is routed via the packet switch to the base station controller serving that mobile terminal, and means for decapsulating the data packet, and delivering the packet to the mobile terminal.

5. A mobile communications network having means for 10 delivery of packet data services from a packet data network to mobile terminals served by the mobile network, the mobile network including a mobile switching centre for providing voice communication facilities to mobile terminals via respective base station controllers and base stations, a home location register for storing information relating to 15 said mobile terminals, a packet routing system comprising a gateway support node providing an interface with the packet data network and one or more serving support nodes each coupled to the gateway support node and to one or more base station controllers for delivery of data packets to the mobile terminals, the packet routing system 20 including means for encapsulating each data packet, means for retrieving from the mobile network to the data packet network said stored information indicative of the mobile network location of each said mobile terminal adapted to receive packet data services, means for providing each said encapsulated data packet with a temporary 25 address corresponding to said mobile network location whereby that packet is routed via the packet switch to the base station controller serving that mobile terminal, and means for decapsulating the data packet, and delivering the packet to the mobile terminal.

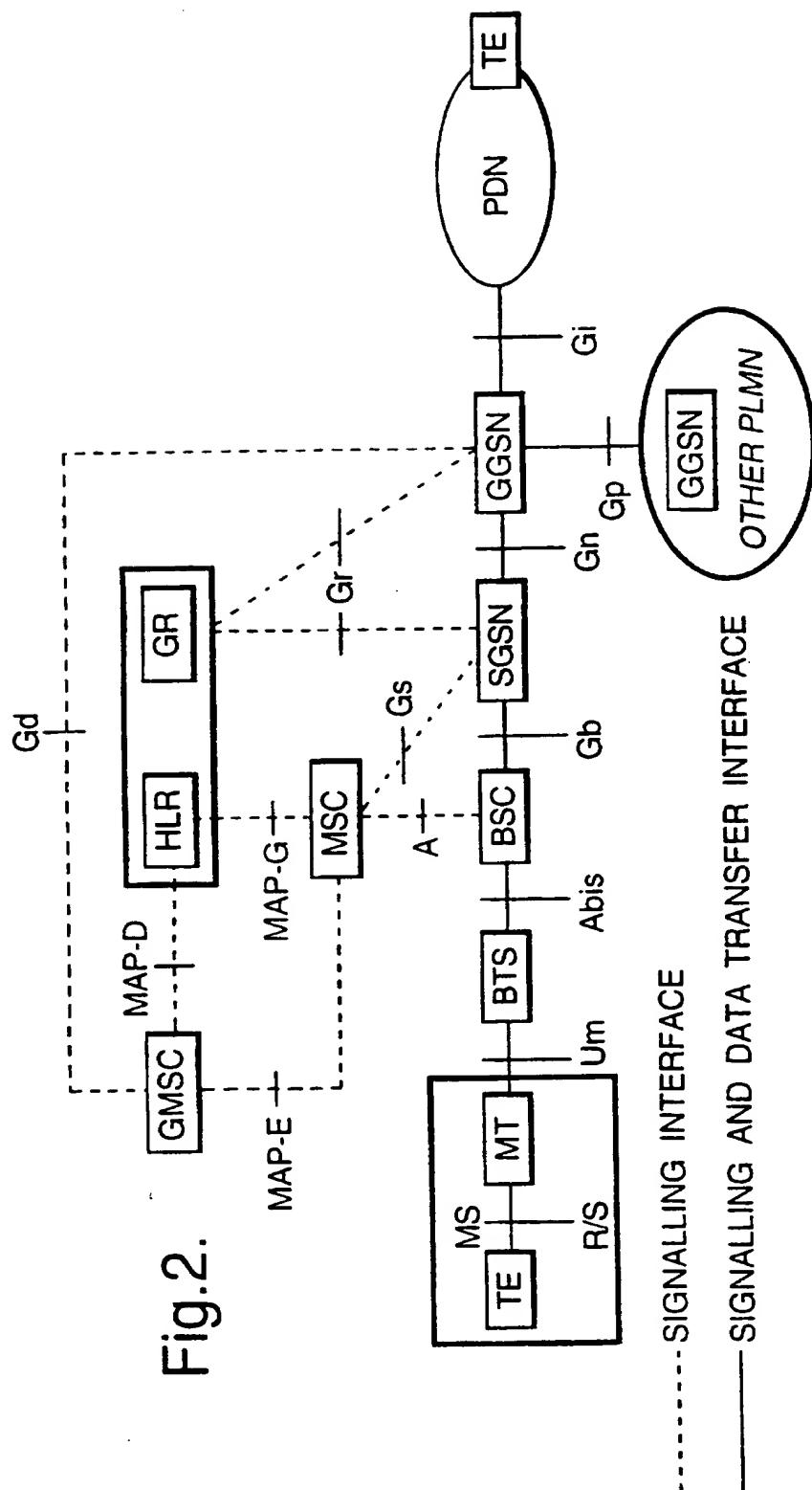
30 6. A mobile communications network as claimed in claim 5, wherein the packet network has means for encapsulating packet data in a first format for transport between the gateway support node and a said serving support node and in a second format for transport between a said serving support node and a said base station 35 controller.

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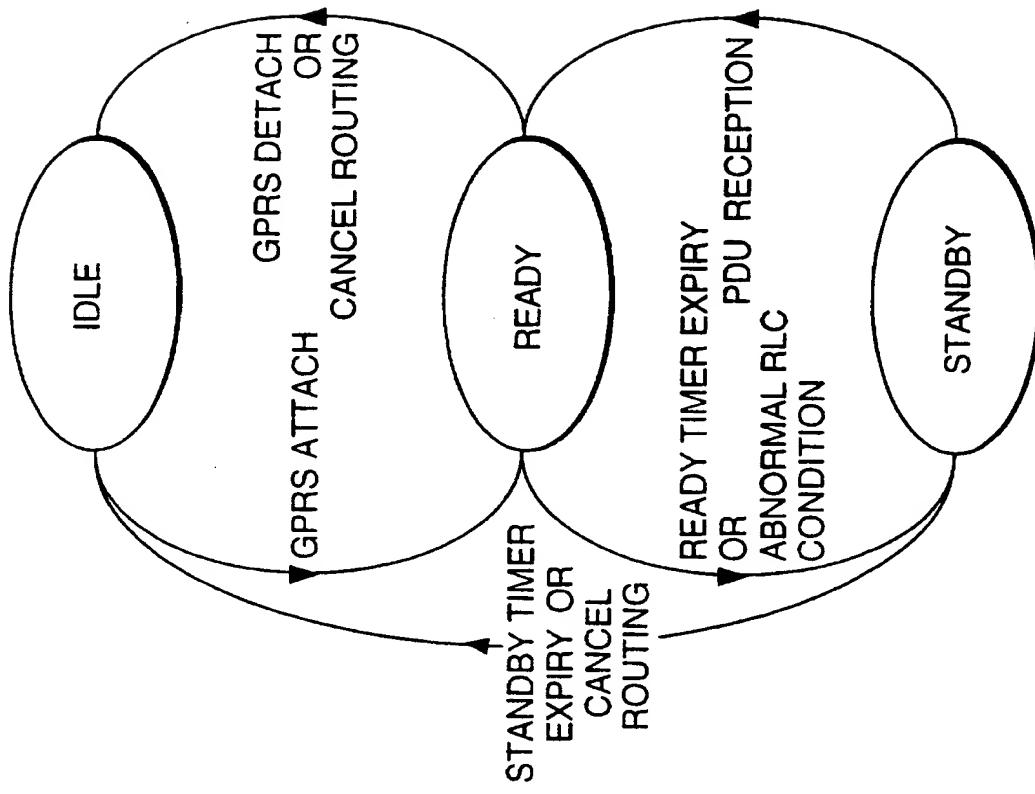
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**Fig.5.****Fig.6.**

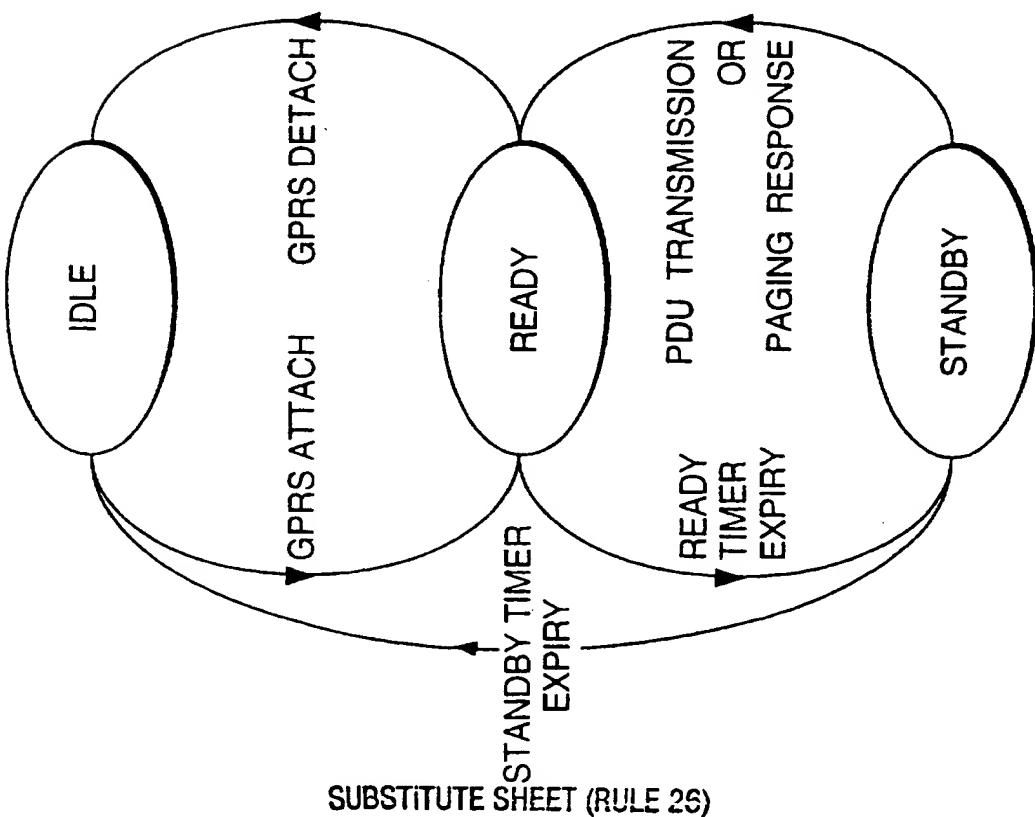
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**Fig.3b.**



MM STATE MODEL OF SGSN

**Fig.3a.**

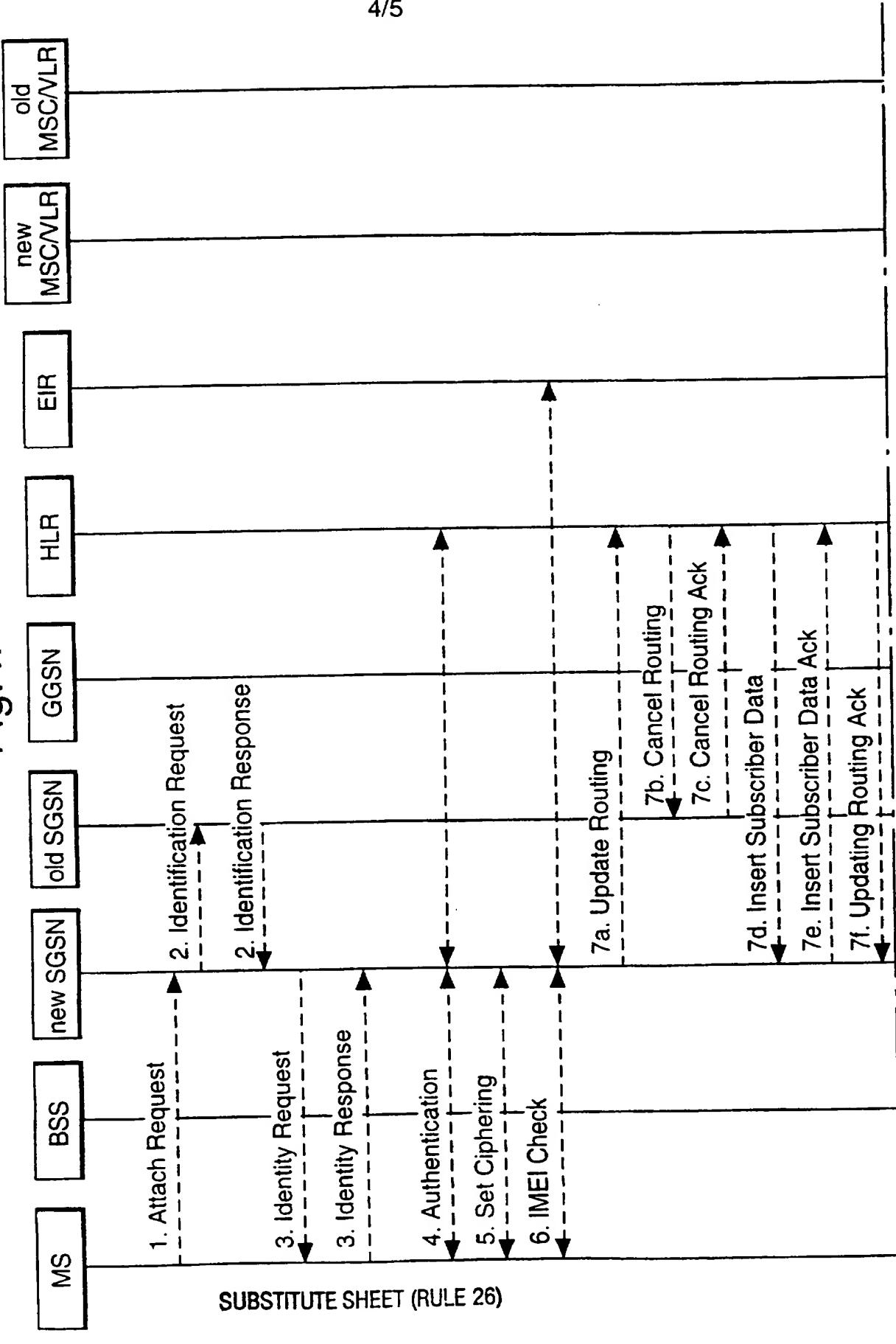


MM STATE MODEL OF MS

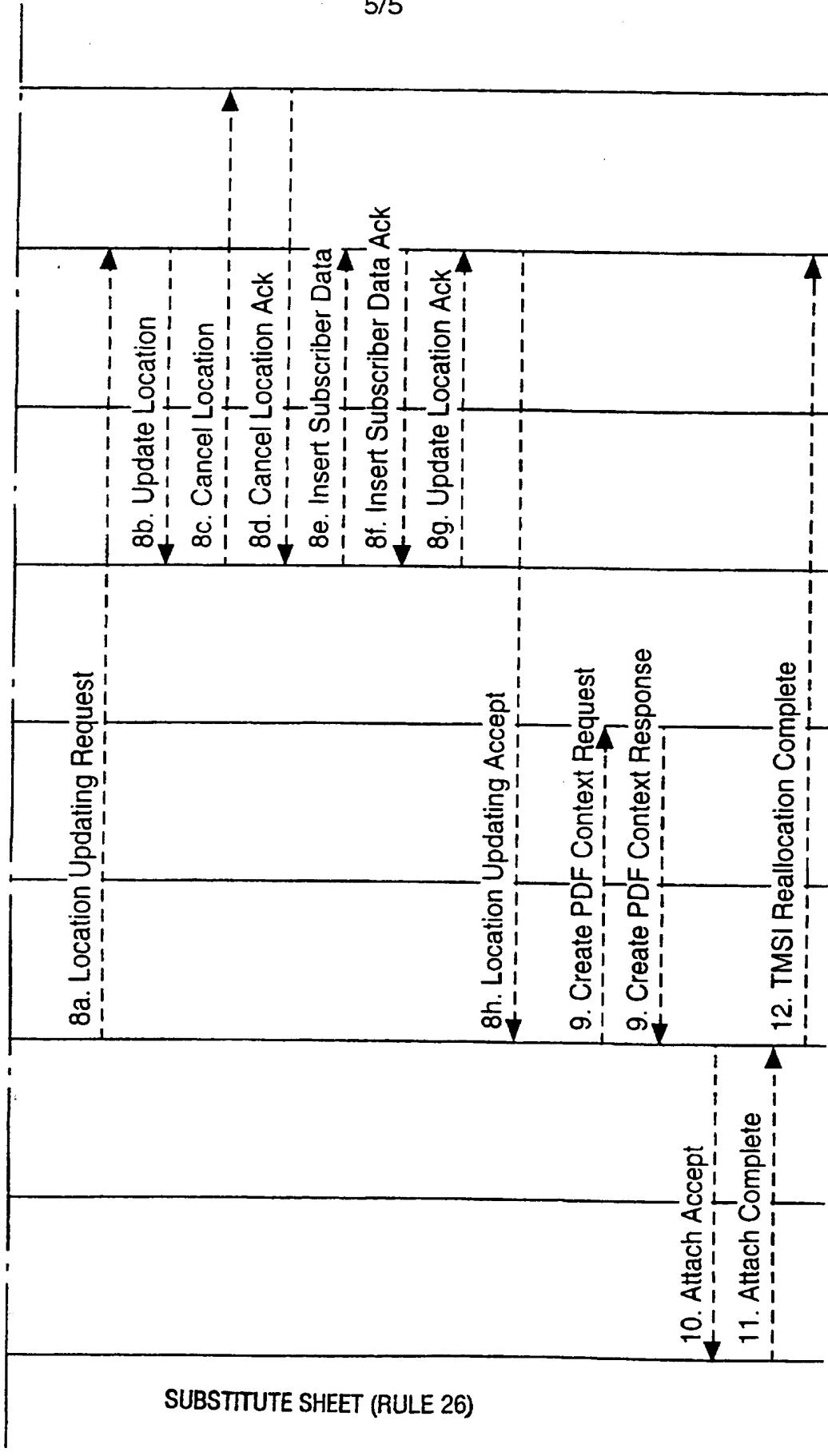
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Fig.4.



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**Fig.4 (Cont).**

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/GB 96/02962

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 6 H04Q7/22 H04L12/56

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 6 H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 95 28063 A (NOKIA TELECOMMUNICATIONS OY ET AL) 19 October 1995 see page 11, line 32 - page 18, line 2 -----	1,2,4,5
A	ISS '95. WORLD TELECOMMUNICATIONS CONGRESS. XV INTERNATIONAL SWITCHING SYMPOSIUM. 23 - 28 APRIL 1995. ADVANCED SWITCHING TECHNOLOGIES FOR UNIVERSAL TELECOMMUNICATIONS AT THE BEGINNING OF THE 21ST CENTURY. PROCEEDINGS VOL. 1, BERLIN, DE , pages 36-40, XP000495534 MADEMANN F: "GENERAL PACKET RADIO SERVICE - A PACKET MODE SERVICE WITHIN THE GSM" see the whole document -----	

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

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Date of the actual completion of the international search

13 March 1997

Date of mailing of the international search report

27.03.97

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 96/02962

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9528063 A	19-10-95	FI 941652 A AU 2778795 A EP 0754395 A	09-10-95 30-10-95 22-01-97
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